PART 5

PROCESS REQUIREMENT

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PART 5

PROCESS REQUIREMENT

5.0 PROCESS REQUIREMENT

Process, hydraulic and other plant design requirements for the upgradation of existing TTP at Yelahanka under present Contract are described herein Part 5 – "Process Requirement".

5.1 Tertiary Sewage Treatment Plant

Design average flow for the Yelahanka TTP = 10 MLD

Peak flow for the Yelahanka TTP = 2.25 x 10 = 22.5 MLD – for design of units for Raw Sewage Pumping Station upto Balancing Tank.

After the balancing tank, the units shall be designed for average flow only.

The TTP at Yelahanka shall be upgraded with following technology:

- **Integrated Fixed-Film Activated Sludge with Biological Nutrient Removal (Nitrification, De-nitrification, and Phosphorus Removal), with existing Tertiary Treatment (Rapid Sand Gravity Filters) and Chlorine Disinfection.**

5.2 Influent Wastewater Characteristics

The influent wastewater characteristics to be used as the basis of design are listed in Paragraph 5.16 – "STP Design/Sizing Criteria and Other Requirements".

5.3 Effluent Quality Requirements

The treated effluent quality requirements to be met are listed in Paragraph 5.16 –"STP Design/Sizing Criteria and Other Requirements".

5.4 Dewatered Sludge Quality Requirements

The sludge quality shall be such that the solids concentration in the dewatered sludge shall not be less than 20 % (+/-)2 % w/w. The dewatered sludge should be truck-able & be suitable for disposal by open body truck.

5.5 Treatment Process

The main treatment process train for STP shall consist of the major processes units and components as listed in Paragraph 5.16 TTP Design/Sizing Criteria and Other Requirements. This list shall not be considered as a comprehensive description. The Contractor shall provide a complete, fully functional facility designed for proper, easy operation and to meet the stated performance requirements. This shall include any and all additional, ancillary, supporting, or other processes, components, equipment, or other items necessary to achieve these objectives, regardless of whether such items are explicitly listed in this Bidding Document or not.

The design/sizing criteria, minimum number of units, and other requirements for the various unit processes and components are listed in Paragraph 5.16, and Part 11.

5.6 Demolition or Interfaces and Tie-Ins with Existing Facilities

All existing facilities that are to be demolished shall be properly decommissioned, removed, and appropriately disposed-off by the Contractor in accordance with all applicable laws, regulations, and standards. Items, components, or materials, whether buried, exposed, submerged, or otherwise, shall not be abandoned or left on site unless explicitly indicated in the Bidding Document. For facilities that are to be eventually demolished but must remain in service until alternate or replacement facilities are constructed and commissioned, whether under this Contract or a different Contract, the Contractor shall ensure that the facilities are protected and remain functional until such time as the alternate or replacement facilities are constructed, tested, commissioned, and accepted by Employer.

All existing facilities that must remain in service permanently shall be protected by the Contractor such that they remain fully functional, operable, and serviceable throughout construction, testing, and commissioning of the new facilities. The Contractor shall be fully responsible for installation and, if necessary, ultimate removal of any temporary facilities or connections (piping, utilities, power, controls, etc.) that may be necessary to maintain existing facilities fully operational throughout construction and commissioning. Temporary or permanent interfaces between existing and new facilities may involve making connections or "tie-ins" to existing live structures, piping, wiring, cabling, equipment or other components. The Contractor shall be fully responsible for detailed design, planning, and implementation of such interfaces in a safe and secure manner.

The contractor shall ensure the operation of at least one stream (50% of plant capacity) and shall carry out the proposed upgradation works as mentioned in document and drawing elsewhere.

5.7 Modular Design, Construction, and Operation for Reliability, Redundancy, Turndown, and Easy Future Expansion

The design capacity is specified in Paragraphs 5.1 for TTP. This paragraph shall be read in conjunction with other relevant paragraphs and parts of the Bidding Documents.

For all components under this Contract, the capacity to be provided shall be designed and constructed using multiple, suitably sized unit process modules to ensure reliability, redundancy, and appropriate turndown for optimum capacity utilization and process efficiency. The minimum number of working and standby modules or units required for each component shall be as listed in Paragraph 5.16, and Part 11 of the Bidding Documents.

5.8 Design of Plant Layout

The proposed project components shall be laid out and fully contained within the respective designated site boundaries. The Contractor shall take full responsibility for designing, planning and programming the Works within the site

The Contractor's proposed site layout for TTP shall clearly show the space allocated for all plant components, including those components and/or unit processes that are designated for future construction or installation, if any. Setbacks and clearances from the site boundary shall be provided as appropriate and as required by law.

All existing utilities (including water, sewer, power, or others, whether overhead or underground and whether physically located on the site or not) requiring to be relocated to accommodate the Contractor's proposed and approved site layout shall be relocated by the Contractor at no additional cost and without interrupting provision of such utility services to users and customers. Such relocations shall be fully coordinated with the Employer.

The plant layout shall adhere to the following minimum requirements, regardless of whether or not such requirements or any related components are shown in any drawings or specifically listed or described in any part of the document included in the Contract Document.

- Minimum clear distance provided to permit safe and convenient access for operation and maintenance shall be 3m between adjacent treatment units or fixed structures and 1.2m between pieces of equipment.
- Access and maintenance lay down area shall be provided adjacent to all mechanical equipment.
- All electrical equipment (except for motors) shall be located above the high flood level elevation for the site or for the effluent receiving water body, whichever is higher.
- All process units / storage tanks shall be labeled with name, sizes and volume. Letters shall be of a size suitable for the application but shall not be less than 100mm high. Labels shall be located at 90-degree intervals at a suitable elevation.
- All plant items for mechanical, electrical and instrumentation shall be fitted with a unique name plate bearing the individual plant reference name for the plant item.
- Contractor shall generate master asset database of TTP and should update same during O&M period. Further, all assets shall be labeled with unique asset number with barcode which shall be linked to master asset database of plant and shall provide all details of asset when scan the barcode.
- Access facilities shall be provided for People with Disabilities; at minimum for all the locations at Finished Ground Level and Finished Floor Level.
- Admin building shall be provided with three side glass capsule Elevator having capacity to carry minimum Six (6) People at a time.
- Contractor shall provide bird eye view of entire plant by constructing viewing area above admin building. Further, contractor shall ensure that elevator of admin building shall terminate at bird eye view area.

- Minimum 1500mm wide continuous walkway shall be provided for walkthrough of liquid stream process units which shall start at Inlet Chamber of TTP and end at Chlorine contact tank outlet channel. Crossing of this walkway with plant internal road shall be painted as "WALKWAY".
- Minimum 1200mm clear width of platform shall be provided to all process units like Inlet works, aeration works, clarifiers, tertiary filters, CCT, sludge sumps and any other location as required to meet the access requirement as specified in tender.
- Vehicular access shall be provided for all plant structures and utility buildings. A pedestrian access door shall be provided adjacent to each vehicle access door in a building. Vehicular routes within buildings shall be clearly marked and process equipment, pipes, cables etc. shall not be located within one (1) meter of a marked vehicular route; appropriate physical protection shall be provided for equipment, pipes, cables etc. located close to a vehicle access route to minimize the risk of damage.
- All plant internal roads and plant approach road shall be of asphalt macadam and minimum width shall be as specified in tender document.
- All the roads shall be provided with minimum Curb radius of 3.5m unless specified otherwise.
- All roads shall be provided with storm drain on either side of road or single side based on drainage flow pattern and shall be constructed to prevent standing water.
- All the roads shall be provided with painted concrete curb stone on both side of road with minimum concrete curb stone height as 300mm.
- Minimum 750mm of paved walkway shall be provided on either side of road which shall be 300mm above the road surface. Contractor shall propose storm drain below this walkway.
- Contractor shall ensure that all plant internal roads shall be provided with 100mm edge line marking, this shall be marked at 300mm away from curb stone on both sides of road with industrial grade paint.
- Proper drainage of the area around all the buildings shall be provided to avoid stagnation of rain water to prevent malarial conditions.
- Contractor shall appoint dedicated Architectural Engineer for developing Architectural view of complete plant, further contractor shall ensure that architectural view of all process and non-process building shall reflect the current era architecture as approved by Engineer.
- Contractor shall appoint dedicated Landscaping Engineer for developing Landscape layout of complete plant, further contractor shall ensue that landscaping view of complete plant should be pleasant and shall reflect modern landscaping practice of current era.
- Plantation & horticultural activities of landscaped area shall be properly maintained to give pleasant environment of build out campus throughout the O&M period.
- The speed limit for all vehicles within plant boundary shall be not more than 15kmph and same shall be displayed at suitable locations within plant road, at least at road intersection. Further, all

the road intersection within plant shall be provided with direction boards at suitable elevation as directed by Engineer.

- Display hoarding for safety signs at suitable elevation shall be provided both indoors and outdoors. These safety signs shall cover mandatory, prohibition, warning, emergency, fire-fighting and general notices as directed by Engineer.
- Display hoarding of painted plant layout shall be placed outside the admin building at suitable elevation as directed by Engineer.
- A Scale model of all the facilities within the plant boundary shall be displayed inside the Admin building with brief description of each unit process. Model shall be kept inside the glass box having dimensions 2.4m Length x 1.8m Width x 0.45m Height. The Model shall be placed at suitable height above the Finished Floor Level as directed by Engineer.

5.9 Design Requirements

The following design requirements shall be meant for TTP including the Pumping Station. These requirements shall be fully met regardless of whether or not such requirements or any related components are shown in any drawings and other documents included in the Contract Document.

- The Contractor shall perform a complete Hazardous Area Classification analysis as per IS 5572 for STP in this contract and shall submit a complete report of such analysis as well as Hazardous Area Classification Drawings that delineate boundaries of all classified areas and indicate the classification of each area. All electrical or other powered equipment, instrumentation, or components shall fully comply with all requirements of IS 5571.
- All components (including but not limited to equipment such as pumps, blowers, screens, diffusers, inline devices; instruments such as flow meters; and distribution and collection channels or pipes) shall be provided with appropriate isolation devices such as valves, gates, or other devices in order to allow isolation, drainage, cleaning, calibration, servicing, and maintenance of such components.
- Bypasses shall be provided around all flow meters and other in-line instrumentation such that the instrument can be isolated and removed for calibration and maintenance without interrupting the flow, regardless of whether or not such bypasses are shown in any drawings included in the Contract Document.
- All equipment, where necessary and particularly blowers, shall be provided with acoustic, sound-dampening enclosures to limit ambient noise during normal operation to the limits as detailed in General and particular specification.
- Suction air filters provided for process air blower shall capable of supply the process air that should not contain more than 0.02 mg of dust per m^3 of process air.

- Cooling arrangement shall be provided to ensure process air temperature of less than 80°C at the common air header at the bioreactor, and insulation shall be provided to the airline(s) till that point wherever there is a possibility of human contact with the airline.
- All equipment shall be arranged, and buildings and structures designed to permit safe and easy access to and removal of all equipment.
- Fixed runways, lifting eyes, cranes, hoists, or other appropriate devices and means shall be provided to permit safe and easy removal of all equipment for maintenance or any other purpose.
- Minimum 1.5 factor of safety shall be incorporated over maximum weight to lift while selecting the capacity of any type of lifting device.
- All structures, whether liquid-holding or not, shall be designed such that they can be fully and completely drained and will not float or move when empty, because of groundwater buoyancy or any other reason. The structures shall be designed to counteract any possible floatation without the use of any type of groundwater pressure relief valves, including during construction.
- The floors of all liquid-holding structures shall be appropriately sloped and trenches and drain sumps shall be provided at the bottoms of such slopes to facilitate complete drainage of liquid. Appropriate drain pipes and valves connected to the drain sump(s) shall be provided for all structures. Where the drain pipe connects to the structure, the top-of-pipe elevation shall be at least 150 mm lower than the lowest floor elevation for the structure. The drain piping shall be routed from the structure being drained to the Plant Drain Pump Station. For liquid-holding structures, the drain piping and fittings shall be sized such that the entire structure can be drained by gravity in no more than eight (8) hours. The Plant Drain Pumping Station, Plant Drain Pumps, and other related equipment and controls shall be designed and sized to allow draining of the structure with the largest volume from full to empty within eight (8) hours. The highest design water level (High-High Alarm) in the Plant Drain Pumping Station wet well shall be at least 300 mm lower than the lowest pipe invert elevation amongst all drain pipes connecting to the wet well.
- Non-liquid-holding areas, structures, or buildings where leakage or other wet activities can occur, whether in normal use or during maintenance, shall be provided with covered drainage channels which shall direct the spillage either to a suitable gravity drain or to a sump equipped with standard dual submersible sump pumps discharging to the Plant Drain Pump Station.
- Interceptor and containment bunds shall be provided for containment of all chemicals, fuel and wash water as a resultant from spillages and overflows. The Contractor shall take due regard to the potential of hazardous mixing of chemicals, particularly as a result of leaks and spillages, and their drainage and containment.
- All concrete structures in contact with sewage and/or sludge shall be provided with full interior corrosion protection linings and/or coatings; this shall apply to all concrete structures in contact with any type of sewage and/or sludge anywhere in the plant including but not limited to complete

works of Inlet works, Primary Sedimentation tanks, Anoxic zone, Aerobic zone with media, Final Sedimentation tanks, Sludge storage sumps, Channels etc.,

- Complete chlorine contact tank including its free board and its inlet & outlet channel shall be provided with White/Sky Blue porcelain - like finish free from any pits or recesses to avoid accumulation of bacteria and dirt, else which might hinder to achieve desired outlet fecal coli-form.
- All channels carrying process liquid shall be fully covered with solid non-skid GRP cover plates (not grating) designed for human traffic live loads at a minimum and heavy vehicle live load wherever the channel crosses traffic paths.
- Inlets into tanks, reactors, or other structures via pipes, channels, valves, or gates shall be designed such that the incoming flow does not cause any damage or excessive wear whatsoever to the structure (including corrosion protection linings and/or coatings) or any equipment in the vicinity under any hydraulic condition, including but not limited to the condition when the structure is empty.
- Walkways, flooring, hand railing, Plant, etc. shall be designed to take account of the prevailing conditions and be of corrosion-resistant materials. The Contractor's attention is drawn in particular to areas including, but not limited to Inlet Works.
- All walkways and staircase shall be provided with non-skid floor tiles of industrial grade designed for human traffic live loads and equipment load that carried on walkway. Whereas all the admin building requirements including staircase, flooring etc., shall be as specified elsewhere in this Bidding Document.
- Dedicated working area shall be provided on aeration tank for proper access, lifting and maintenance of installed mixers, valves, flow meters and pumps.
- If process air diffusers in the bioreactor are fixed to the floor, then the design should allow taking one bioreactor out of service without any adverse impact on plant capacity and treated effluent quality.
- Contractor shall provide minimum 2400mm clear width of operating platform for aeration tanks
- Flooring of blower room and all type of pump house buildings shall be non-skid in nature and shall be designed to allow for Plant to be removed and stored on the flooring where required for maintenance, in accordance with the Tender requirements and as per good engineering practice.
- Platforms, handrails/guardrails, ladders, stairs and safety chains shall be provided for proper, safe, and easy access to and/or operation of valves, gates, instruments, control panels, and other devices, equipment, or structures, as well as removal of the above items. All platforms and handrails shall be provided with toe guards of minimum 100mm width.
- RCC staircases shall be provided to all treatment plant units, flow dividing chambers and other structures to connect to the elevated RCC walkway platforms for which the height of the floor above finished ground level exceeds that in the prevailing standard.

- All piping shall be of corrosion–resistant material appropriate for the service and shall be provided with interior lining, exterior coating, and other corrosion protection as appropriate and necessary to meet the requirements for design life. All piping shall be fully and adequately supported and braced to comply with all applicable codes and standards. All supporting hardware shall also be of corrosion-resistant material. The design of pipe supports, and anchors shall fully account for static and dynamic vertical, lateral, longitudinal, and seismic loads, fluid flow, and thermal expansion. Seismic bracing thrust restraints and/or thrust blocks, and appropriate expansion joints or loops shall be provided as needed. Pipe lengths and joints shall be assembled and arranged for ease of removal in such a way that individual runs can be changed without dismantling adjacent pipes, by providing dismantling joints at regular intervals.
- All mixed liquor and sludge lines shall be provided with appropriate cleanouts and flushing arrangements for safe and easy flushing using high-pressure water of minimum 3.5kg/cm^2.
- All liquid service pipes shall be provided with appropriate means for safe and easy drainage of the pipes when not in service.
- All pipelines shall be color banded and suitably labeled with the stream designation and direction of flow to enable individual lines to be identified throughout their run. Particular attention shall be paid to the painting of each chemical line, which shall be based on type of chemical flowing in pipe.
- Particular attention shall be paid to the layout of the chemical piping, which shall be arranged without clutter and shall be functional and neat in appearance. Generally, where piping is installed in ducts, it shall be supported not less than 250 mm clear of the floor.
- All piping routed under any type of structure or equipment shall be fully and completely encased in reinforced cement concrete, with the encasement thickness beyond the outer diameter of the pipe being at least 200 mm on all sides. The encasement shall extend along the pipe length for a minimum horizontal distance of 1500 mm in each direction beyond the footprint of the overlying structure or equipment.
- All piping connecting to, entering, or exiting any and all structures shall be provided with appropriate restrained flexible connections and/or joints at all such interfaces with structures to allow for differential movement between pipe and structure in all directions without stressing or breaking the pipes.
- Appropriate restrained flexible connections and/or joints shall be provided for all pipes where they connect to any and all of the following:
    - Equipment such as pumps, blowers, or inline devices
    - Valves
    - Wall, floor, or roof penetrations
- Where piping or other materials susceptible to damage from direct sunlight/ultraviolet radiation, they shall be protected from such light/radiation through the use of appropriate additives and/or coatings and shall be physically shielded from direct sunlight/ultraviolet radiation at all times

(including prior to and during installation) in their normal service location using enclosures, covers, canopies, roofs, and/or other similar means.

- During cleaning cycle of centrifuge, no spillage or washed flows of centrifuge shall fall on the floor of sludge loading area from sludge hopper; design of centrifuge piping arrangement and sludge hopper shall be done such that all washed flows of centrifuge shall pass through centrate line of centrifuge.
- High pressure water jet spray shall be provided to clean the accumulated screening material from both mechanical coarse screen and fine screens to ensure smooth operation while resume from standby to working condition and vice versa.
- For Final Sedimentation Tanks, the design shall provide for separate and independent measurement and control of the flow rate of sludge withdrawal from each individual tank. Such individual control shall be achieved through direct withdrawal of sludge from each unit using one or more dedicated pumps and feedback flow control using separate measurement of flow from each unit. Designs using a common suction header or common wet well shall not be acceptable.
- Appropriate sampling ports and/or sampling valves shall be provided to allow easy, safe sampling of all process streams without spillage or contamination and without the need to interrupt normal operation.
- Foam, scum, fats, oil, grease, or any other floating material removed from any location in the STP shall be completely removed from the process flow path and under no circumstances returned / recycled to any location in the plant.
- All spare requirements specified for diffuser membrane, IFAS media, filter media, mixers and other spare parts of electromechanical equipment's shall be instantaneous. (i.e., equal amount of used spare shall be replaced with new spares to maintain the minimum spare quantity specified in bidding document) throughout the O&M period.
- While selecting any type of pump and blower, priority shall be given to higher pump/blower efficiency and lower power consumption and shall ensure that pump/blower can operate at high efficiency throughout its service life. At minimum contractor shall ensure efficiencies of pump/blower as listed below:
    - Minimum efficiency of Submersible Pumps for shall be 70%
    - Minimum efficiency of Axial Tubular Pump (MLR) shall be 70%
    - Minimum efficiency of RAS Pump (Horizontal/Vertical Non-clog solid handling) shall be 65%.
    - Minimum efficiency of Rotary Tri-Lobe blower shall be 70%
    - Minimum efficiency of Centrifugal Turbo blower shall be 90%
- The Works shall be designed and operated and maintained to minimize odours within, at the boundary of and in the vicinity of the Sites. The layouts of the Works shall take account of the prevailing wind direction and speed at different times of the year. Mature trees shall be provided around the full boundary of all sites, except for at accesses to the sites.

5.10 Hydraulic Design Requirement

A representative layout for the TTP is included in Volume 4 of this Bidding Document. These drawings shall be considered representative only. In the event of any conflicts between information in the drawings and Part 5, then Part 5 – "Process Requirements" shall govern in accordance with the Priority of Documents.

Contractor shall submit self-explanatory hydraulic design calculations in editable MS-Excel format and shall ensure that the plant layouts and hydraulic profiles shall comply with the following specific and all other requirements described in the Bidding Document:

- The Contractor shall provide at TTP, all necessary facilities for manual bypass of the process liquid at various locations in the flow path as indicated below. These facilities are included in this contract and shall be provided regardless of whether or not they are shown in any drawings included in the Bidding/Contract Document. They shall be fully functional in all respects and shall include any and all components necessary to safely and efficiently accomplish the intended bypass. Each bypass facility shall include, but not be limited to: (i) downward opening overflow weir installed in the appropriate channel or structure from which the bypass is to be affected, (ii) an appropriately sized buried (above ground piping will not be acceptable) pipe to carry the bypass flow from the channel or structure. An appropriately sized flow meter along with all associated components and infrastructure to automatically measure and record details of all bypass events, including but not limited to date, start time, end time, continuous flow rate data for the entire duration of the event, and a totalized volume for the event, shall be provided.
- Bypass flow arrangement at the TTP at minimum following locations shall be provided which shall be sized to handle plants peak flows for respective design period as specified in the tender document:
    - At the Downstream of the Grit Chambers and upstream of Distribution chamber of Primary Clarifier Tank to the final outfall structure by gravity.
    - At the upstream of Distribution chamber of Bioreactor to the final outfall structure by gravity.
    - At the upstream of Filters to the final outfall structure by gravity
- Location of outfall structure to discharge treated sewage shall be as directed by Engineer. However, contractor shall ensue that outfall structure shall be located nearest to the receiving water body and flow shall be discharged with cascade effect.
- Topographical survey information, benchmarks, contour maps, geotechnical/soil investigations, and effluent receiving water body high flood level (HFL) elevations for TTP site are included with these Bidding Documents and/or available from the Employer on request. However, the Employer makes no guarantees or representations whatsoever regarding this information. The Contractor's use of this information shall be at his own risk. The Contractor shall independently

obtain any and all site information necessary for proper planning, design, construction and operation and maintenance of all Works/components in the Contract.

- All aspects of the design of the hydraulics shall be based on sound principles and good common engineering practice typical for sewage treatment works.
- All process units shall be capable of passing the required peak sewage flows, including returned flows as specified.
- All the flows shall be evenly distributed between the numbers of process units in operation for all flow conditions.
- The hydraulic design calculations shall demonstrate the hydraulic functioning of the TTP if any one of the process units were to be out of service for maintenance.
- Hydraulic calculations shall be based on the Hazen-Williams formulae for pipe and the Manning equation for open channel flow.
- Hazen-Williams co-efficient of 110 shall be considered for all liquid pipelines for gravity and pumping design.
- For all type of gravity channels, Manning co-efficient of 0.013 shall be considered in design.
- The head loss calculations in all sludge pipe work shall take account of the specific sludge characteristics for different types of sludge including the variations in viscosity arising from changes in the dry solids content and characteristics of the sludge.
- If Contractor's design of sludge line hydraulics is based on Hazen-Williams formula then, Hazen-Williams co-efficient of 60 shall be considered for all sludge piping both for gravity and pumping design.
- The division of flow between the individual treatment units shall be achieved by:
    - Non-submerged (i.e. with a positive freefall from weir invert to the water surface on the downstream side) overflow weirs followed by isolation gate.
    - Non-submerged downward opening overflow weir gates.
    - All air / sludge flow distribution shall be with automatic feedback flow control using inline flow measurement and modulated flow control valves with actuators and data input and control through PLC/SCADA.
- Sharp crested weirs with free discharge shall be used and shall be designed to include adequate provision for maintaining atmospheric pressures beneath the nappe.
- A positive free fall of at least 150mm shall be provided to upstream weir crests under peak flow conditions with all streams operational.
- All the flow distribution boxes shall be equipped with adjustable weir plate for equal flow distribution to each side of weir plate. Further, weir followed by isolation gate shall be provided for each weir side of flow distribution box.
- Weir length of flow distribution box shall be designed to give maximum 150mm of head over the weir at peak flow condition.

- SS 316 weir plate with minimum 6mm thick shall be provided on each weir side of flow distribution box and shall be capable to adjust at least 75mm of its height unless specified otherwise.
- For flow distribution box, at least 1.5m of clear liquid height shall be provided between tip of the weir and invert level of flow distribution box, unless specified otherwise.
- Where flow distribution box receives the flow from channel, the connecting point between incoming channel and flow distribution box shall be provided with minimum 600mm of chamfer followed by under flow baffle wall.
- All pipes and channels shall be provided with proper slope based on calculation. Also, design shall ensure that provided slopes shall facilitate draining of pipes and channels when required during maintenance. At minimum following slopes shall be considered in design unless specified otherwise:
    - All pipe lines carrying plant drain and scum shall be provided with minimum 1% of slope.
    - All channels carrying liquid shall be provided with calculated slope or minimum 1% of slope
    - All gravity sludge lines shall be provided with minimum 1.25% of slope
    - All below ground pumped sludge lines shall be provided with minimum 0.4% of slope.
    - Gravity flow either liquid or sludge shall not be permitted to flow against the slope.
- Bed level of all channels shall be provided with slope, Slope shall be provided either by constructing the bed level of channel as per calculated slope or by providing screeding in channel. If channel is provided with screeding to achieve slope, then a minimum 50mm thick screeding shall be considered at lowest discharge point of channel and accordingly calculated slope shall be provided to upstream side of channel. Contractor shall make a note that flat-bed level of channel without slope is not accepted.
- All corners of channel in contact with liquid shall be provided with fillet having minimum radius of 150mm. Further, change in flow path/direction of channel shall be achieved with smooth curve to avoid turbulence in flow.
- All corners of aeration basin in contact with liquid shall be provided with fillet having minimum radius of 600mm.
- All side corners in contact with liquid in chlorine contact tank shall be provided with fillet having minimum radius as specified in paragraph 5.16. Whereas for other corners of chlorine contact tank in contact with liquid shall be provided with fillet having minimum radius of 300mm.
- All corners in contact with liquid in sludge storage tank/sump and any other storage tank/sump shall be provided with fillet having minimum radius of 450mm.
- The termination end of all the baffle walls proposed in Bioreactor and CCT shall be provided with semicircular end.

- Special care shall be taken to control turbulence, where Raw Sewage, RAS and recycle flows discharge into Bioreactor. Following design feature are illustrated to control the excessive turbulence in anoxic zone and other process unit locations:
    - Construction of the drop chimney/chamber which shall drop the flows to 600mm above bottom of tank. Further plan area of drop chimney/chamber shall be based on velocity criteria which shall be not more than 0.45m/s based on flow to be handled. Alternatively, Construction of the under-flow baffle wall across the flow path which shall terminate 450mm above the bottom of tank with 5minutes retention time based on plant average flow.
- Contractor may carryout Computational Fluid Dynamics (CFD) analysis and results of same shall be incorporated in General arrangement drawings of following process units at minimum:
    - STP Inlet Chamber with Fine Screens
    - Primary Clarifier
    - Anoxic, Aerobic zone
    - Secondary Clarifier
- Minimum number of subzones with physical partition to be provided in anoxic zone is indicated in paragraph 5.16. However, contractor shall ensure that flow path through subzones of anoxic zone shall create the long plug flow condition.
- Submersible type mixer shall be installed in each subzones of anoxic zone. Further, mixer shall be in a location where it shall create dispersion to mix and not to settle condition in flow path of each sub-zone.
- For all structures containing water or process liquid, the minimum freeboard (distance by which top of wall / bottom of slab in case of walkway or closed tank is higher than the maximum water surface level at receiving water under one unit out of service condition for all flow condition shall be 0.5m unless specified otherwise.
- All pumps shall have flooded suction and negative suction shall not be allowed in pump selection.
- Maximum pipe flow velocity shall be not more than 1.0 m/s for all gravity flow and pump suction lines unless specified otherwise.
- Maximum pipe flow velocity shall be not more than 1.5 m/s for all pumped discharge lines unless specified otherwise.
- Calculated normal velocity (at 20°C and 1atm) of air piping shall not be more than 16 m/s.
- For channels, the maximum velocity shall be no more than 1.0 m/s.
- For liquids the maximum velocity through gate opening shall be not more than 0.8 m/s unless specified otherwise.
- Maximum velocity through inlet ports of secondary clarifier shall be not more than 150 mm/s.
- The size of magnetic flow meter shall be same as that of pipe diameter unless specified otherwise.
- The minimum elevation difference between High water level and High-High water level shall be at least 300mm.

5.11 Potable Water System

Potable water shall be provided and used for safety showers, domestic potable needs, polymer solution preparation, and laboratory needs. Separate booster set to supply potable water to a potable water ring main shall be provided. Potable water shall be drawn, via a break tank of capacity 7000Litres, from the main feed to the Site as directed by Engineer. The break tank shall be fitted with the potable water booster set. The potable water booster system shall be designed to a minimum pressure of 1.5 bar at the furthest point from the booster set on the potable water ring main under conditions of maximum water use.

5.12 Process and Facilities Description

This Process and Facilities description is intended to provide the processes and types of facilities that the Contractor shall be required to design, construct, and operate, and apply to STP in this Contract unless specifically indicated otherwise. The Contractor shall use this description together with other specific information for STP provided elsewhere in this Bidding Document, including but not limited to Paragraph 5.16, Part 11, & Volume 4 – "Drawings", all of which are integral to this Process and Facilities Description and are incorporated herein by reference. Contractor shall strictly comply with the specified treatment concept, treatment unit processes, flow configuration (connectivity between unit processes and facilities), performance requirements (such as effluent and sludge quality and equipment efficiencies), and design criteria (such as design operating conditions, various process loading rates and/or detention times, requirements for units out of operation, volumes, and dimensions where specified) such as the minimum requirements specified in the paragraph 5.16.

5.13.1 Receiving Chamber

The existing Receiving Chamber is adequately sized to receive the full peak flow of 22.5 MLD from the trunk main. This incoming sewage shall flow by gravity to the Mechanical Coarse Screen Channel which will also house J-Type trash racks.

5.13.2 Coarse Screen Channel

The sewage shall be conveyed by gravity from receiving chamber to the common chamber with two gates opening to two channels installed with one number of J-type Manual screen and one mechanical Coarse Screen installed in deep concrete channels. Each screen is designed for peak flow of 22.5 MLD.

J type screen shall be installed upstream of Mechanical coarse screen with aperture size of the screen shall be minimum 50 mm and installed at 90 angle of inclination. The screen shall be rigidly fixed to the frame. The screen shall be provided with appropriate lifting devices so that the screens can be brought to the ground floor for removing the trapped material.

One Mechanical Coarse Screen shall have 20 mm openings and an electronically controlled automatic jam removal system shall be provided in addition to the safety devices. The screenings removed by

the screens shall be discharged at the appropriate elevation above ground on to a conveyor. A screw or belt conveyor positioned above ground level shall convey the screenings through a SS304 chute to a screening collection bins positioned at ground level. Each coarse screen channel will be provided with thimble mounted isolation Sluice gates both on upstream and downstream.

5.13.3 Grit Channel

Two numbers Grit Channels exist. No modification is proposed here.

5.13.4 Balancing Tanks

Two numbers balancing tanks with capacity 26 m x 16 m x 6 m each exist. These tanks are required to stabilise both the flow and the pollution load entering the plant. Each tank is supplied with two mixers to avoid any settling in the tanks.

It is proposed to provide Submersible Mixers for these tanks so as to keep the raw sewage thoroughly mixed to avoid settling and septicity.

Mixers for Balancing Tanks

Type: Submersible Mixer

Nos. and Capacity: 4 nos. total – 2 nos. in each tank of 7.5 HP each

5.13.5 Raw Sewage Pumping Station

The submersible pumps, two working and one standby, each of capacity 225 m^3/hr. at required head shall be provided for pumping sewage from sump to inlet chamber. This is same as the existing pump capacity.

5.13.6 TTP Inlet Chamber

Sewage pumped from the screened sewage sump flows to a stilling chamber designed for peak flow with 30 seconds retention time to minimize turbulence and provide smooth flow to fine screen channels. The stilling chamber is proposed of adequate size (2.9mLx2mWx1.5SWDm) to meet the requirements of workability inside it. The receiving chamber is open to sky and shall be water tight to prevent seepage of the sewage out of it.

5.13.7 Fine Screens

Raw water is pumped into an inlet channel and then to Automatic Inlet Screens. A manual raked screen is also provided as standby.

Two fine screen channels are provided, each designed for peak flow of 450 cum/hr with appropriately sized isolation gate(s) upstream and downstream of each screen. The Fine Screens have openings of 6mm, and will be placed in concrete channels. An electronically controlled automatic jam removal system shall be provided in addition to the safety devices. The screenings removed by the screens shall be discharged at the appropriate elevation above ground on to a

conveyor. A screw or belt conveyor positioned above ground level shall convey the screenings through a SS-316 chute to a screening collection Bins positioned at ground level.

These screens shall be replaced with new ones.

5.13.8 Grit & Grease Removal Chambers

The screened sewage shall flow by gravity through a common channel into two circular Grit Chambers, each sized for full peak flow and constructed in RCC. Each one is composed of one turbine, two upper grease scrappers, one grease drainage valve, one grease chamber, one sand drainage valve and one sand disposal area.

Air is injected into the middle of the tank by one submerged turbine in order to float grease onto the surface of the tank. An upper scraper skims and collects the grease into a chamber. Once a month a truck will be required on site to collect the contents of the grease chamber.

The mechanical parts shall be replaced with new ones and ensure that the desired performance is achieved.

Existing unit details:

Nos : 2 (1W+1S)

Dia : 4.15m

Height : 4.09 m (Excluding cone depth)

Capacity : 450m3/hr

Air flow (Submerged aerator) : 33m3/hr

Grease production : 0.045 l/m3 (486 l/day)

Sand production : Approx 1200 kg/day (40m3/day, 30g/l)

5.13.9 Primary Settlers

Two numbers of primary Settler scraping bridges are continuously in service to remove suspended solids from the raw water. Each tank has a scraper to push settled sludge into its hopper. The primary settler scraper bridges are complete with an integral control panel and starter. Scum is removed by a top scraper equipped with a rubber slim.

Nos.	2
Diameter	13.85 m
SWD	3 m

5.13.10 Aeration Basin Influent Channel and Bioreactor Distribution Chamber

As per existing system.

5.13.11 IFAS Bioreactor

The proposed technology for upgradation of existing Bioraector is IFAS using existing aeration tank. IFAS is a treatment process that combines suspended and attached growth processes. Media is placed into the bioreactor tank in order to promote attached growth of the biomass, which effectively makes more biomass available in the system for treatment. Media to be used shall be moving media / floating media. Bidder’s design should be compatible with existing hydraulics and completely utilise the existing aeration tank, with minimal / no requirement for additional bioreactor tanks.

Integrated Fixed Activated Sludge (IFAS) reactor shall be provided with suitable high-density polyethylene (virgin HDPE) media, media retention screens and fine/coarse bubble aeration system. Fine or Medium bubble diffusers uniformly placed at the bottom of the aerobic reactor will maintain a dissolved oxygen (DO) concentration as per the duty requirements, and will also keep the media in circulation. To retain the media flowing out of the IFAS tank, screens shall be placed on the partition walls.

The media fill will be 30% to 50% of tank volume. The effective specific surface area of media shall be between 500-800 m^2/m^3 and density of the media shall be less than 1.0 but not less than 0.94. Media Retention Screen shall be designed based on peak/maximum flow. Media Retention Screen shall be made of Stainless Steel, Type 316 or higher.

Biological reactor shall consist of at least Anoxic Tank and IFAS Tank; bidder may propose Anaerobic Tank, but it shall be accommodated within the existing bioreactor tank. The wastewater from primary clarifier shall enter by gravity to the anaerobic / anoxic tank where it shall mix with the RAS / Internal Nitrate Recycle respectively. The Anaerobic and Anoxic tanks shall be provided with submersible type mixers. From anoxic tank wastewater shall enter the aerobic IFAS tank. The existing aeration tank shall be upgraded for BOD and nitrogen removal and to achieve an effluent quality as prescribed. The IFAS Process has been chosen because the upgraded effluent quality can be achieved utilizing the existing aeration tank without any increase in volume.

The existing bioreactors shall be rehabilitated with necessary modification as per the process design requirement by constructing partition walls in the existing tank. There are two numbers existing conventional aeration tanks provided with surface aerators.

The Bidder should provide detailed bioreactor calculation including but not limited to bioreactor volume, media volume, basis for adopting nitrification rate on media and on MLSS, air requirement, and nitrate and sludge recycle rate.

Contractor shall submit complete calculations and full documentation demonstrating compliance with these requirements. The following design factors mentioned in Table 5.1 shall be considered for the design of the Bioreactor:

Table 5.1: Design factor for design of Bioreactor

S No	Description	Requirement
A	**General**	
1	Continuous maximum Flow	10 MLD + Recycle of in plant wastewater
2	Material of Construction of Tank	RCC (Existing Tank) – partition walls to be constructed
3	No of Streams	2 nos.
4	MLSS	As per Bidder's design
5	Liquid Depth	SWD = 2.85 m
6	Free Board	Minimum 0.5m
7	Internal MLSS Recycle	As per Bidder's design
8	Return Bio Sludge (RAS)	As per Bidder's design, piping for RAS ratio of 1

S No	Description	Requirement
9	SVI	100-140 ml / gm
10	Specific Sludge yield of suspended growth microorganism	0.6 to 0.9 KgVSS / KgBOD
B	**IFAS Reactor**	
1	Media quantity	As per Bidder's design (30% to 50%)
2	Min Percentage media fill	30 %
3	Media Active Surface Area m^2/m^3	500 to 800 m^2/m^3
4	DO in IFAS	3 mg/l
5	Media MOC	HDPE (virgin)
6	Density of media	0.94 to 1.0
7	Media Retention Screen	Media retention screen to be designed for Peak Flow + Sludge Recycle + MLR Recycle of 300% or more MOC of Screen SS 316
8	Aeration System	Fine Bubble/Medium Bubble diffusers Maximum aeration diffusers efficiency not more than 16 gms O_2/ per m^3 air per m liquid depth
9	HRT	As per design
C	**Aerobic Bio Reactor**	
1	Minimum DO in Reactor	2 mg/l
2	Aeration system	Fine bubble membrane disk diffusers with a maximum flux of 70 m^3/m^2 membrane area.
3	Diffusers MOC	PP / HDPE body with silicon or PU membranes

Note:

1. Due consideration must be given for providing anti foaming arrangement in Bioreactor

2. The Kinetic Coefficients for heterotrophic, nitrification and de-nitrification bacteria will be as per CPHEEO Manual latest edition or as given in 'Wastewater Engineering – Treatment and Reuse' by Metcalf and Eddy Inc., Fourth Edition may be used for design in the absence of representative data for Indian conditions.

Wastewater from individual aerobic zones shall flow by gravity to the channel leading to Secondary Clarifier distribution chamber. The existing channel from Bio Reactor to the distribution chamber of secondary clarifier shall be rehabilitated as per civil specifications. As per system requirement, all existing isolation gates, valves, pipe line etc. at Bio Reactor out-let channel leading to Secondary Clarifier shall be replaced along with all existing electro-mechanical system.

a. Anoxic Zones

Wastewater shall enter by gravity to the anoxic zone first where it shall mix with the internal recycle from the last section of the aerobic zone to ensure de-nitrification to the extent possible. Anoxic zone shall be provided with submersible type mixers.

The following design factors are to be considered for the design of the Anoxic Zones:

Table 5.2: Design factor for design of Anoxic Zone

Sr. No.	Description	Requirements
A.	**Anoxic Zones**	
i.)	Continuous maximum Flow	10 MLD + Recycle or Other flow (if any)
ii.)	No of Streams	2 nos.
iii.)	Material of Construction	RCC M30
iv.)	Hydraulic Retention Time	As per Bidder's design
v.)	Liquid Depth	SWD = 2.85 m
vi.)	Free Board	Minimum 0.5m
vii.)	Internal recirculation ratio	As per Bidder's design, but minimum 300%.
viii.)	Return Sludge Ratio	70%, however hydraulic design for 100%
ix.)	Anoxic MLSS	3,000 – 4000 mg/l
x.)	Type of Mixer	Submersible type
xi.)	Nos. of Mixers	Minimum 2 per basin
xii.)	MOC of Mixers	As per approved list of makes
xiii.)	Mixing Requirement	6 - 10 Watt/cum (minimum)

Note: Due consideration must be given in the design to the need for emptying tanks for maintenance and repair of the aeration equipment. The Intermediate wall could be with water on either side.

b. Aerobic Zones

Wastewater from IFAS zone shall flow to aerobic zone. The bio reactor aerated section shall be oxygenated using fine air bubble diffused aeration and shall effectively bio-degrade the organic matter and organic/ ammoniacal nitrogen in the primary clarified wastewater to the required soluble BOD/ nitrogen level of purity. The sizing of the aeration basins shall be consistent with the design, sizing, and performance criteria specified below. Contractor shall submit complete calculations and full documentation demonstrating compliance with these requirements.

The testing procedure for diffusers shall be performed in conformance with procedures described in "Measurement of Oxygen Transfer in Clean Water" published by the American Society of Civil Engineers (ASCE, 2007). Routine plant operating data or anecdotal data shall not be acceptable as basis for calculating the parameters. Contractor shall submit complete calculations and full documentation for the performance tests.

The Kinetic co-efficient for heterotrophic, nitrification and de-nitrification bacteria as given in 'Wastewater Engineering – Treatment and Reuse' by Metcalf and Eddy Inc., latest edition should be

used for design. The design procedure may follow the process design as given in 'Wastewater Engineering – Treatment and Reuse' by Metcalf and Eddy Inc.

The following design factors are to be considered for the design of the Aerobic Zones:

Table 5.3: Design Factor for design of Aerobic Zone

Sr. No.	Description	Requirements
A.	**Aerobic Zones**	
i)	Continuous maximum Flow	10 MLD + Recycle or Other flow (if any)
ii)	No of Streams	As per design requirement to suit existing condition.
iii)	Material of Construction	RCC M30 (Existing)
iv)	MLSS	3,000 – 4000 mg/l
v)	F/M Ratio (BOD)	0.3 (maximum)
vi)	Kg of Oxygen required/kg of BOD removed	1.2 Kg. (minimum)
vii)	Kg of Oxygen required/kg of NH4 –N Nitrifed	4.6 Kg O2 per kg of NH4 –N Nitrified
viii)	Specific Sludge Yield	0.6 to 0.9 kg VSS/ Kg BOD
ix)	Hydraulic Retention Time	As per Bidder's design
x)	Aerobic Solids retention time	As per Bidder's design
xi)	Min. DO in the Aeration tank	2 mg/l
xii)	Liquid Depth	SWD = 2.85 m
xiii)	Free Board	0.5 m
xiv)	Internal recirculation ratio	300%
xv)	Return Sludge Ratio	70%,(minimum)
B.	**Aeration Requirements**	
i)	BOD Oxidation Oxygen Requirement	1.2 x Inlet BOD Load
ii)	Nitrification Oxygen Requirement	4.6 x TKN Nitrification
iii)	Denitrification credit	Max 50% of denitrification
iv)	Total Requirement	BOD Oxidation + Nitrification Oxygen Requirement
v)	Min. Dissolved oxygen to be maintained in the Aeration tank	2.0 PPM

Sr. No.	Description	Requirements
vi)	Application of Correction factor	Shall be as per equation (5-55) Page 430 of book "Wastewater Engineering – Treatment and Reuse' by Metcalf and Eddy Inc., Fourth Edition may be used for design.
vii)	SOTR calculation factors	Alpha = 0.6 max Beta = 0.9 Diffuser fouling = 0.8 max
viii)	Type of diffuser	Fine bubble membrane disc type/ tubular type grid diffusers, Diffuser should be removable without emptying the tank.
ix)	Diffuser membrane MOC	Silicon elastomer or PU
x)	Specific air flow rate of Diffuser	70 $m^3/m^2/hr$ of membrane area
C	**Process Air Blower**	
i)	Nos. of Process Air Blowers/Compressors	Minimum one number blower per aeration tank and 50% Stand-By (minimum) of total nos.
ii)	Type of Blowers	Hi Speed Centrifugal / Turbo Blowers with energy efficient motor
iii)	Air Blower Capacity	As per Contractor's Design
iv)	Discharge Pressure	As per Contractor's Design

Suitable Air cooling system shall be provided to reduce the temperature of compressed air from discharge of air blower before entering in to the Aeration tank.

Wastewater from individual aerobic zones shall flow by gravity to the Aeration tank effluent channel.

From Aeration tank effluent shall flow by gravity to the channel leading to Secondary Clarifier distribution chamber.

5.13.12 Blower Room

Air shall be supplied to the bioreactor tanks through diffused aeration system. Blowers along with acoustic enclosures shall be placed in air blower room. Contractor shall provide new air blower room near aeration tanks.

The air blower room shall have RCC framed structure and the brick panel walls shall be 230 mm thick. The plinth level of the building shall be 500 mm above the G.L.

5.13.13 Blower Panel Room

For controlling the blowers, the required electrical panels shall be housed in the blower panel room located near aeration tanks and air blower room. The plinth level of the building shall be 500 mm above the G.L. The ceiling height up to the soffit of the roof beam shall be minimum 5000 mm.

5.13.14 Jet Aspirator / Aerators

Contractor to refer part 8 for specification.

Aeration system for the aeration zone after IFAS tank may be designed with Jet aspirators / suitable aerators / diffused aeration as per bidder's design

5.13.15 Alum Dosing System

An alum dosing system shall be provided to accomplish backup chemical phosphorus removal in the event of inadequate biological phosphorus removal. The Alum Storage, Solution Preparation and Dosing System shall be housed in Alum Storage Building complete with suitable hoist, etc. The solid alum may be stored on the first floor while the solution preparation and dosing system may be on the ground floor of building.

Alum dosing system shall be provided for maximum alum dose of 90 mg/l and 10% alum solution strength. Contractor shall provide minimum three numbers alum dosing pumps, (2 working + 1 standby) of required capacity for chemical phosphorus removal in the event of inadequate biological removal.

5.13.16 Aeration Basin Effluent Channel

Each Aeration basins effluent channel included in this contract shall be designed and constructed for design peak flow 10 MLD + Recycle/return/RAS flow. It shall carry secondary treated wastewater to the Final Sedimentation Tank (FST) for solids separation.

5.13.17 Flow Distribution Chamber for Final Sedimentation Tank

As per existing system

5.13.18 Final Sedimentation Tank/Secondary Clarifier

The mixed liquor from the Aeration Tank shall flow by gravity to two existing Final settling tanks of 17m dia x 3 m SWD. Final Settling tank plays an extremely critical role ensuring the sustainability and stability of the biological process and consistency in the treated effluent quality. This is ensured by a design which helps in retaining very efficiently the biomass/ sludge within the settling tank while allowing treated effluent with minimum possible suspended solids to overflow out of the settling tank. The FST has a sloping bottom. The sludge settled at bottom of FST is collected at the out let of FST. The sludge from the bottom is withdrawn out of the FST out let through a sludge pipe which is connected to the RAS Sludge Sump. Manual Flushing Valves along with the high pressure piping connection is also provided to flush the pipeline in case of any choking. The floating scum in the FST shall be skimmed with the help of skimmer system and pushed into the Secondary Scum Pit through gravity DI pipes.

5.13.19 Return Activated Sludge Sump and Pump House

Secondary Sludge sump is provided to collect RAS Sludge and WAS sludge. Pump house shall house Return Activated Sludge (RAS) pumps and Waste Activated Sludge (WAS) pumps The RAS pumping sludge sump shall include the submersible pumps, supporting structures, chain pulley block with motorized operated travelling hoist for maintenance of pumps and motors. The RAS discharge mains shall be provided with flow-meter to measure RAS and WAS flow rates.

The following are the details of the proposed RAS & WAS Pumps:

RAS Pumps

No. of pumps working	2 nos.
No. of stand by pumps	2 nos.
Capacity of pumps	225 cum/hr

WAS Pumps

No. of pumps working	1 no.
No. of stand by pumps	1 no.
Capacity of pumps	25 cum/hr

Internal Recycle Pumps

The mixed liquor from the aeration basin is continuously pumped to Anoxic basin for de-nitrification. Two numbers working and two numbers standby pumps of low head Submersible tube pumps which continuously pump from aeration basin to Anoxic reactor.

Submersible Mixers (Anaerobic and Anoxic)

Submersible type mechanical mixers shall be provided in the anaerobic and anoxic basins to ensure adequate mixing energy. The modern submersible mixers are designed to achieve the desired mixing and suspension of the MLSS in the bioreactors with most optimized volumetric energy consumption.

5.13.20 Tertiary Sand Filters

There are four existing sand filters, each comprising a tank with inlet at high level to deliver settled water onto a bed of filter media and an under floor system of nozzles to collect the filtrate and deliver it into a filtered water channel. There is a system of pipes and valves that are controlled form time to time so that the tank is taken out of use and the filter media backwashed with water and air. Design filtration rate is 9.83 m/hr (with 4 filters in use) and 13.11 m/hr (with 3 filters in use).

The existing single filter media to be converted into dual media filters with thickness of sand layer of 1m, 0.8m layer with Anthracite and 0.1m layer of Gravel.

Filter Coarse Sand Media and Anthracite shall be hard and resistant quartz or quartzite and free of clay, fine particles, soft grains, dirt of every description. The filter Coarse sand shall consist of hard, durable grains of silica and shall have a specific gravity between 2.55 to 2.65. Silica content shall not be less than 90%. The filter Coarse sand shall consist of hard, durable grains of silica and shall have a specific gravity between 2.55 to 2.65.

The anthracite media shall have high carbon content of not less than 90% (minimum) and Ash content not more than 7% (maximum), low specific gravity to reduce backwash rates and energy consumption. The particles shall be Angular in shape for low head loss and better filtration rate.

The Anthracite shall confirm to the UK and European Standards EN12909-2005 and American Standards of AWWA-B100-1 NSF61.

The filter media shall be as follows:

Coarse sand media:

- Specific gravity :2.55 to 2.65

- Depth :1.0 m (minimum)

- Effective size :0.4 to 0.8 mm

- Uniformity coefficient :1.3 to 1.5

Anthracite

- Specific gravity :1.50 to 1.60

- Depth :0.8 m (minimum)

- Effective size :0.8 to 1.0 mm

5.13.21 - Uniformity coefficient :1.3 to 1.5Chlorine Contact Tanks

Filtered effluent from Tertiary Filters flows to chlorine contact tank by RCC channel/pipe. Chlorine Contact Tank is provided for dosing of chlorine. Baffle walls are provided to achieve plug flow for proper disinfection. All the inner walls shall be lined with acid resistant tiles. Chlorine shall be injected in the inlet distribution chamber through perforated pipe (diffuser assembly) just upstream of CCT. Gas chlorination system shall be provided to dose chlorine.

Chlorination System:

Number of Units	:	2 (1W + 1S)
Type	:	Gas Chlorination
Chlorine Dosing	:	15 mg/l (max)
Capacity of Chlorinator	:	7 kg/hr.

Chlorination system comprising of chlorine tonners (2W+6S+1SS), chlorinator (1W+1S), booster pumps (1W+1S), ejector, lifting device with weighing scale, leak detection and leak absorption

system, safety equipment's like canisters, gasmasks etc. and other ancillary shall be provided in the chlorine house. It is proposed to have sufficient ventilation as per the latest norms for safety purpose with necessary lifting arrangement and Electric hoist of minimum 2T capacity etc. complete. A chlorine gas scrubbing system shall also be provided to scrub out leaked chlorine gas (minimum caustic pumps (1W+1S) and Blower (1W+1S).

5.13.22 Final Treated Effluent Channel

There is existing treated water tank with capacity 1668cum to store treated water. The treated water is being supplied to Bangalore International Airport and other consumer along the airport road through airport transfer pumps.

5.13.23 Sludge Treatment

Gravity Thickeners

One numbers of thickener (picket and fence type) of 13 m dia., is existing in the plant.

Thickened Sludge Sump

The thickened sludge sump will receive sludge of about 2.5% consistency from the thickener. Sludge mixing shall be performed either through a recirculation line from the dewatering feed pumps or through a sparger type blower system.

Dewatering Centrifuge feed pumps

Positive displacement screw type sludge transfer pumps (1W + 1S) shall be provided to transfer thickened sludge to Mechanical Dewatering Units. One tapping from the screw pump delivery line shall recirculate the sludge back to the thickened sludge sump to mix the sump contents.

Mechanical Dewatering Units

The mechanical dewatering units shall be solid bowl centrifuge /screw press designed so as to give a 100% trouble free operation at all times and the sludge dewatering plant should operate for designed flow and capacity conditions and be sized as per design criteria. Polymer solution shall be added to the sludge to improve dewatering performance. Existing Belt Filter Press units shall be decommissioned and removed.

The de-watering system should be so located that the de-watered sludge can be loaded into trolleys / drums / bins directly. The de-watered sludge should be truck-able & be suitable for disposal by open body truck and should have a minimum solid concentration of 20% or more (measured as dry solids w/w basis).

A hoist shall be provided above centrifuge for maintenance purpose. The hoist shall be such that it shall be possible to erect or de-erect the centrifuge while one centrifuge is in operation.

Number of Centrifuges : 2 Nos. (1 Working+ 1 Standby)

Type	:	Horizontal, solid bowl
Capacity of each unit	:	5 m^3/hr.

Mixing arrangement of Polyelectrolyte and sludge: online-mixing

Polyelectrolyte Dosing

The polyelectrolyte will be dosed online at the centrifuge inlet. Minimum dosage of polyelectrolyte shall be 2.5 kg/T of dry solids in sludge, and the maximum polymer solution concentration should be 0.2% solution strength. There shall be two poly-dosing tanks each suitable for minimum 8 hrs. of operation. Each-tank shall be equipped with slow speed mixer (100 RPM) to prepare polyelectrolyte solution. The solution will be fed using positive displacement metering type dosing pumps, each of minimum 370 lit/hr. capacity. There shall be dedicated dosing pumps (one working and one stand by) to each centrifuge.

The pumps shall be interlocked with centrifuge so that it can only be running in auto when centrifuge is on and should shut down when centrifuge stops. The dosing system shall be housed in centrifuge building itself.

5.13.24 Bore wells

Bore Wells shall be provided for pumping fresh groundwater to a separate RCC overhead tank with RCC support structure as necessary to provide the required elevation and water pressure. Bore well water shall be further treated to domestic potable standards before using it for safety showers, domestic potable needs and laboratory needs. The water system shall be designed to provide adequate water pressure for all of the above applications.

5.13.25 Administration, Laboratory, Maintenance, and Other Related Buildings/Facilities

An administration building with furniture (including SCADA room), a laboratory, a maintenance workshop, a storage facility, a guard house, process & electrical buildings and all related facilities shall be provided for a fully functional facility of TTP as described elsewhere in the Bidding Document.

5.14 Flow Measurement

A complete flow measurement facility shall be provided at minimum locations as specified below to measure the flows at minimum 99% accuracy. All equipment and components necessary for a fully functional facility shall be provided for all flow measurement locations regardless of whether or not such items are specifically listed or described in the Bidding Document.

a) Flow measurement of raw sewage at inlet chamber of TTP
b) Overflow/bypass flow measurement at Downstream of the Grit Chambers.
c) MLR flow measurement to each Anoxic zone
d) RAS flow measurement

e) WAS flow measurement

f) Process air flow measurement to each Aerobic zone and its sub-zones

g) Flow measurement on common alum dosing line

h) Final effluent flow measurement at outlet of CCT/treated water tank

All the above locations shall be provided with continuous flow measurement. Flow measurement devices shall provide instantaneous and totalized flow records and signals. Flow measurement devices shall be linked to the PLC/SCADA system to allow daily totalized flow and other flow trends to be analyzed, recorded and for control of process as specified in tender document.

5.15 Sampling/Analysis Locations and Frequencies

Sampling and analysis shall be performed to measure the parameters indicated in the table below, at the locations and frequencies indicated in the table. In case of multiple units (such as multiple aeration basins, multiple clarifiers), the indicated sampling and analyses shall be performed for each individual module. Further, Contractor shall ensure that all the historical sampling data and analysis results shall be stored in database and made available to Employer till end of contractor's O&M period.

Parameter	Frequency	Measurement / Sampling Method	Points / Locations
pH	Continuous	Online	1) at D/S of Grit Chamber 2) Final Effluent
	Daily	Grab sample	1) Anoxic Zone 2) Aerobic Zone 3) All plant bypass flows
COD	Daily	Flow-weighted 24-hours composite sample	1) At D/S of Grit Chamber 2) Final Effluent
		Grab sample	1) All plant bypass flows
	Continuous	Online	1) Final Effluent
rbCOD	Daily	Flow-weighted 24-hours composite sample	1) Raw Sewage 2) Sewage at D/S of Grit Chamber
TSS	Daily	Flow-weighted 24-hours composite sample	1) Sewage at D/S of Grit Chamber 2) Final Effluent
		Grab sample	1) All plant bypass flows 2) Waste Activated Sludge (WAS) 3) Plant Drain Flows
	Continuous	Online	1) Raw Sewage at TSPS 2) Final Effluent
VSS	Daily	Flow-weighted 24-hours composite sample	1) Raw Sewage at TSPS 2) Sewage at D/S of Parshall flume

Parameter	Frequency	Measurement / Sampling Method	Points / Locations
			3) Final Effluent
		Grab sample	1) All plant bypass flows 2) Waste Activated Sludge (WAS) 3) Plant Drain Flows
Chlorine	Daily	Grab sample	1) All plant bypass flows 2) Final Effluent 3) Plant Water
	Continuous	Online	1) CCT Inlet 2) CCT Outlet
Turbidity	Continuous	Online	1) U/S of Filter 2) D/S of Filter
ORP	Continuous	Online	1) Anoxic Zone 2) Chlorine Contact Tank
BOD_5 at 20°C	Daily	Flow-weighted 24-hours composite sample	1) Sewage at D/S of Grit Chamber 2) Final Effluent
		Grab sample	1) All plant bypass flows 2) Plant Drain Flows
	Continuous	Online	1) Final Effluent
TKN	Daily	Flow-weighted 24-hours composite sample	1) Sewage at D/S of Grit Chamber 2) Final Effluent
Ammonia-N	Daily	Flow-weighted 24-hours composite sample	1) Sewage at D/S of Grit Chamber 2) Final Effluent
		Grab sample	1) All plant bypass flows 2) Anoxic Zone 3) Aerobic Zone
	Continuous	Online	1) Raw Sewage at TSPS 2) Final Effluent
Nitrate-N	Daily	Flow-weighted 24-hours composite sample	1) Sewage at D/S of Parshall flume 2) Final Effluent
		Grab sample	1) All plant bypass flows 2) Anoxic Zone 3) Aerobic Zone
Total Nitrogen	Daily	Flow-weighted 24-hours composite sample	1) Final Effluent
		Grab sample	1) All plant bypass flows
	Continuous	Online	1) Final Effluent

Parameter	Frequency	Measurement / Sampling Method	Points / Locations
Alkalinity	Daily	Flow-weighted 24-hours composite sample	1) Sewage at D/S of Grit Chamber 2) Final Effluent
		Grab sample	1) All plant bypass flows 2) Anoxic Zone 3) Aerobic Zone
Total Phosphorus	Daily	Flow-weighted 24-hours composite sample	1) Raw Sewage at TSPS 2) Sewage at D/S of Grit Chamber 3) Final Effluent
		Grab sample	1) All plant bypass flows 2) Aerobic Zone
	Continuous	Online	2) Final Effluent
Fecal Coli-form	Daily	Flow-weighted 24-hours composite sample	1) Raw Sewage 2) Final Effluent
		Grab sample	1) All plant bypass flows 2) Plant Water
Total Coli-form	Daily	Flow-weighted 24-hours composite sample	1) Raw Sewage 2) Final Effluent
		Grab sample	1) All plant bypass flows 2) Plant Water
VFAs	Daily	Flow-weighted 24-hours composite sample	1) Sewage at D/S of Grit Chamber
MLSS	Daily	Grab sample	1) Anoxic Zone 2) Aerobic Zone
MLVSS	Daily	Grab sample	1) Anoxic Zone 2) Aerobic Zone
Temperature	Daily	Online	1) Sewage at D/S of Grit Chamber 2) Anoxic Zone 3) Aerobic Zone 4) Final Effluent
Specific Gravity	Daily	Grab sample	1) Chemicals 2) Sludge
Concentration / Water Content	Daily	Grab sample	1) Chemicals 2) Sludge 3) Grit
Organic Content	Daily	Grab sample	1) Grit
Volume	Daily	Grab sample	1) Chemicals

Parameter	Frequency	Measurement / Sampling Method	Points / Locations
			2) Screenings 3) Grit
Sludge Volume Index	Daily	Grab sample	1) Aeration Basin Effluent Channel
DO	Daily	Grab sample	1) Sewage at D/S of Grit Chamber 2) Final Effluent
	Continuous	Online	1) Aerobic Zone 2) Anoxic Zone
Microscopic Examination	Monthly Once or as needed	Grab sample	1) Anoxic Zone 2) Aerobic Zone 3) Final Effluent
Odour	Weekly	Japanese Offensive Odor Control Law (Law No. 91 of 1971, Latest Amendment by Law No. 71 of 1995). **Or** Prevailing Indian Standard as directed by Engineer.	1) Preliminary Units 2) All Pump House Building
	Monthly		1) Plant Boundary
Noise	Daily	Decibel Meter	1) All process buildings including pump house
	Monthly	Decibel Meter	1) Plant Boundary

All costs associated with the sample collection and lab analysis shall be met by the Contractor. The analysis shall be carried out and shall be performed in strict compliance with appropriate analytical methods published in Indian Standards, or in "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, or as published by the US Environmental Protection Agency.

In addition, the Contractor is required to validate its analysis on effluent samples monthly once from an approved laboratory (by Bureau of India Standards), which is not connected to the Project. The validation sampling shall be randomly taken based on Employer decision and the cost of validation/ analysis shall be borne by the Contractor.

During the entire operation and maintenance period, Employer shall nominate their official/counterparts for the inspection of specific STP on a weekly basis. Employer shall also

nominate a qualified person to carryout periodical inspection of the STP and to conduct surprise checks, without prior notice to the Contractor.

Employer shall check the effluent quality of the STP every day and instruct the Contractor to undertake appropriate remedial measures, if the performance of the plant is observed as not satisfactory.

Employer shall engage an approved agency (or Bureau of Indian Standards Certified Laboratory) for assessing the effluent quality, for which the samples shall be jointly collected by the Employer (or Bureau of Indian Standards Certified Laboratory) and the Contractor.

In the event of breakdown of the flow-weighted 24-hours composite sample equipment, sampling shall be undertaken manually in a day at every two-hour interval and the results shall be weighted according to flow in order to establish the equivalent daily total load.

5.16 STP Design/Sizing Criteria and Other Requirements

Contractor shall submit self-explanatory process design calculations in editable MS-Excel format considering the requirements specified in Part 5 and elsewhere in this Bidding Document. Further contractor shall also submit simulation Model of process design by using BiowWin software.

Below Notes are pertaining to design and sizing criteria specified in following tables:

a) All the process unit sizes/volumes specified are minimum.

b) *All the building dimensions (or Area when calculated) specified are minimum; However, Contractor may upsize these dimensions (or Area when calculated) based on design to meet the specified tender requirements.*

5.16.1 Minimum Requirements

Item/ Parameter/ Description	Units	Yelahanka TTP
General Information		
TTP-Location		Yelahanka
Plant Capacity	MLD	10MLD
Influent Wastewater Flow		
Avg. flow to STP	MLD	10
Peaking Factor (PF)		2.25
Recycle flow rate		Shall be included in design as per flow and mass balance and pumped back to STP Inlet chamber
Influent Wastewater Characteristics		
pH		6.5-7.5

Item/ Parameter/ Description	Units	Yelahanka TTP
BOD	mg/L	350
COD	mg/L	720
TSS	mg/L	450
VSS	mg/L	270
TKN	mg/L	55
NH_4-N	mg/L	45
Total Phosphorus	mg/L	10.5
Alkalinity	mg/L as $CaCO_3$	370
Min. Sewage Temperature (Tmin)	^OC	24
Max. Sewage Temperature (Tmax)	^OC	27
Min. Ambient Temperature	^OC	15
Max. Ambient Temperature	^OC	45
Treated Effluent Quality Requirements (at outlet of chlorine contact tank)		
pH – instantaneous range		6.5 –9.0
BOD_5 at 20^0C	mg/L	5
COD	mg/L	50
TSS	mg/L	5
NH_4-N	mg/l	1
N Total	mg/L	10
Alkalinity – min instantaneous	mg/L as $CaCO_3$	>70
Total Phosphorus	mg/L	1
Residual Chlorine – instantaneous	mg/L	>1
Fecal Coliform	MPN/100 mL	Nil
Note: At the inlet and outlet of the sewage treatment plant, multi-parameter online monitoring devices should be provided to monitor above all parameters.		
Treated Sludge Quality Requirements (Dewatered Sludge)		
Sludge Quality		Undigested Dewatered sludge
Maximum Sludge VSS/TSS	%	70%
Minimum sludge TSS (dry solids) for Sludge	% w/w	20%
STP Inlet and Outlet Hydraulic Conditions		

Item/ Parameter/ Description	Units	Yelahanka TTP
Receiving water body/To consumer		Allalsandra Lake/ Bangalore International Airport and other consumers along the airport road.
RSPS at TTP? (Y/N)		Y
TTP at Yelahanka		
Aeration Basins (Existing)		
No of Units		2
MOC – Structure		RCC
SWD	m	2.85
Freeboard	m	0.5
Total Volume	cum	2480
Secondary Treatment		
Process Type		Integrated Fixed-Film Activated Sludge (IFAS)
Flow Distribution		
Inlet flow distribution		Through flow distribution box equipped with weir plate for equal flow distribution to each tank. Each weir shall be followed by isolation gate to each tank.
Outlet flow		Through overflow weir.
Anoxic to Aerobic Zone		Submerged weir
Aerobic Zone to Deaeration		Through overflow weir.
Tank Geometry		Rectangular tank with flow distribution box and Inlet & outlet channels. Inside configuration of the rectangular tank shall be such that it shall create pass flow to meet the design condition as specified.
Bioreactor Basin Influent Channel (existing)		

Item/ Parameter/ Description	Units	Yelahanka TTP
No of Units	Nos	1.00
Design factor for design of Bioreactor		Refer Table 5.1
Anaerobic Zone		As per Bidder's design
Anoxic Zone		Refer Table 5.2
Aerobic Zone		Refer Table 5.3
No of Tanks - Working	Nos	2.00
Bioreactor Basin Effluent Channel		
No of Units	Nos	1.00
Process Air Blowers		
Oxygen demand at average flow (AOTR)	kg/d	194
Aeration system sizing basis process liquid temperature	^{0}C	27.00
Minimum DO Level of Aeration basin	mg/L	2.00
α: Oxygen Transfer Correction Factor	-	0.60
β: Salinity - Surface Tension Correction Factor	-	0.9
F: Fouling Factor	-	0.80
Design SOTE per m depth of water (Minimum to be provided and maximum to be used as design basis)	% /m	5.50
Blower capacity safety factor	-	1.2
Blower capacity to be provided at normal condition (20 deg C and 1 atm)	m^3/hr	7000.00
Total number of working blowers	Nos	2.00
Total number of standby blowers	Nos	1.00
Blower type	-	Turbo / Rotary Tri-Lobe PD with VFD Control
Process Air Diffusers		
Type of Aeration	-	Diffused Aeration
Diffuser type	-	Fine bubble membrane, tubular or disc, fixed type
Membrane material	-	Silicon / PU
Min % of uninstalled spare diffusers	%	5.00
Blower Building		
Number of Building	Nos	1.00
Ground Floor		
Length	m	12.00
Width	m	8.00

Item/ Parameter/ Description	Units	Yelahanka TTP
Height	m	6.00
First Floor		
Length	m	8.00
Width	m	8.00
Height	m	5.00
Dewatering Building/ Centrifuge		
Centrifuge		
Capacity of centrifuge	m^3/h	5
Number of centrifuge-working	No.	1.00
Number of centrifuge-standby	No.	1.00
Operating hours for centrifuge	Hrs/day	16.00
Inlet Sludge Consistency	%	3
Outlet sludge consistency from centrifuge	%	20.00
solid capture from centrifuge	%	95.00
Centrifuge type		Solid Bowl Decanter Centrifuge
Poly Dosing System		
Type		Dry polymer with batch tanks
Minimum polymer dose	kg/ton dry solids	2.50
Polymer Storage		
Type		Dry, covered bin
MOC		GRP
Minimum storage period	days	30
Storage safety factor		1.50
Min no. of storage bins		1
Min capacity per bin	kg	350
Polymer Feeder		
Type		Dry gravimetric or volumetric "atomizing" educator
Min no of units/Tank		1
Batching period	days/batch	1

Item/ Parameter/ Description	Units	Yelahanka TTP
Polymer requirement - batch avg	kg/batch	8
Operating time	min/batch	30
Min capacity per feeder	kg/min	0.52
Polymer Batch Tanks		
MOC		GRP
Polymer solution strength (maximum)	% w/w	0.2%
Solution volume required	cum/batch	3.9
Solution storage volume safety factor		1.50
Min no of tanks - Working	tanks/batch	1
Min no of tanks - Standby	tanks/batch	1
Minimum working capacity per tank	cum	5.9
Liquid depth	m	5.0
Tank diameter	m	1.2
Polymer Batch Tank Agitator		
Min no of Agitator per tank		1
Total no of Agitator		2
MOC - Impeller and shaft		SS316
Type		Turbine
Polymer Metering Pumps		
Type of Pump		Hydraulic double diaphragm
Polymer solution requirement - peak	cum/hr	0.2
Min no of pumps - Working		1
Min no of pumps - Standby		1
Min capacity per pump	cum/hr	0.37
Dewatering building (existing)		
Number of Building	Nos.	1
Number of Floors	Nos.	1
Bore well pumps		
No. of units – Working	No.	1
Type of pumps		Submersible
Min. capacity of pumps	LPM	135

End of Part 5